



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE DEVELOPMENT OF THE GONAD AND GONODUCTS IN TWO SPECIES OF CHITONS.

ROSE M. HIGLEY AND HAROLD HEATH.

The later development of the chitons has never been fully investigated, and the fragmentary observations that have been made relate almost exclusively to immature forms in very advanced stages. Accordingly we are at present almost wholly ignorant of the development of the principal systems of organs and their homologies. Many of the more important questions relating to these animals center in the formation of the coelom, and it was with the hope of throwing some light on this subject that the present work was undertaken.

The two species that form the basis of this investigation, *Trachydermon raymondi* and *Nuttallina thomasi*, are fairly abundant forms in certain localities along the coast of California, and owing to their small size are readily sectioned. The free-swimming young¹ were placed in aquaria together with fragments of shells of *Mytilus californica* on which they finally settled after partially completing their metamorphosis. They were then transferred to small and protected tide pools where they developed normally and in several instances were allowed to reach the sexually mature condition. Precautions were taken to keep the young of each species in separate pools and it was found that they travel essentially the same developmental path for a long period. Distinguishing characteristics accordingly appear late, in fact considerably beyond the formation of the gonad and its ducts. It is to be understood therefore that while the figures are of *T. raymondi* they serve equally well for *N. thomasi*.

At a very early stage the heart and pericardial cavity are developed from cells, giving evidence of being derived exclusively from the secondary mesoblast (progeny of 4*D*), which forms an irregular layer on the postero-dorsal side of the larva. A relatively long period of time then ensues, during which the

¹ For breeding habits of these species see *Zool. Anz.*, Bd. XXIX., No. 12.

other systems of the body develop to practically the same condition as in the adult, before the gonad makes its appearance. When the primitive sex cells become recognizable they usually form two groups attached to the anterior external surface of the pericardium from which they appear to be proliferated. Very soon, in rare instances at the time of their formation, these become so closely appressed as to appear single though sections show them to be distinct for a considerable time, frequently after the gonoducts have formed. Shortly after their appearance a cavity forms within each group, and, with the growth of the gonad, soon becomes more or less triangular. In later stages,

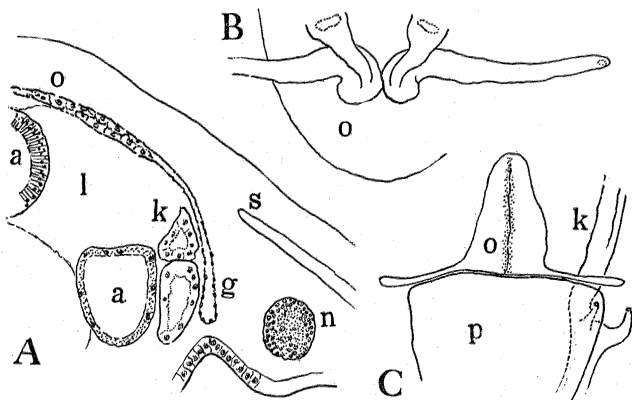


FIG. 1. Gonad and ducts of *Trachydermon raymondi*. A, section through animal about 1 mm. long. a, digestive tract; g, gonoduct connecting with gonad; k, kidney; l, liver; n, lateral nerve cord; s, shell. B, gonad (o) and ducts in mature animal, dorsal view. C, reconstruction of same stage as Fig. 1. Gonad with ducts ending blindly; kidney showing reno-pericardial and external openings.

generally about the point of development represented in the figure, these cavities gradually fuse, commencing at the posterior end of the gonad and progressing anteriorly. In some individuals a slight groove may persist on the ventral surface between the halves of the gonad for a considerable time, and in a few cases a distinct cleft at the anterior end of the gland persists until the animal is half grown.

The aorta holds the normal position on the dorsal surface of the gonad, and there are slight evidences that a portion of the blood it carries makes its way between the halves of the

organ as in the solenogastres. At all events there are no signs of distinct branches penetrating the gland as in the later stages.

About the time of the fusion of the gonad cavities (when the length of the body is approximately 1 mm.), in a stage slightly earlier than the one represented in Fig. 3, each gonoduct arises as a slender evagination of the postero-lateral walls of each half of the reproductive gland. These grow rapidly, and in contact with the pericardial wall proceed laterally and ventrally until they come in contact with the ectoderm of the mantle groove. In the formation of the outer opening the ectoderm cells appear merely to separate; if an ectodermic diverticulum is formed it is evidently very short and transitory.

In later stages the proximal ends of the gonoducts shift forward slightly, and are attached to the dorsal side (Fig. 2) of the gonad close to the mid line. During this process their walls thicken, and at the height of the breeding season there are signs of secretory activity on the part of the component cells especially in the neighborhood of the reproductive organ. The eggs of both of these species are held in the mantle cavity, and are loosely bound together possibly by this secretion of the oviduct.

The only other observations bearing on the development of the gonoducts are those of Plate¹ who has made the claim that in the young of *Acanthopleura echinata*, 15 mm. in length, the gonad is completely separated from the gonoducts that, as slender diverticula, are connected with the mantle cavity and are accordingly ectodermic. Granted that this is the true state of affairs in *A. echinata* it is unprofitable for the present to attempt to correlate the two types of development when only three species of chitons have been examined on this point. However, it is interesting to note that in several species of California chitons² three millimeters or less in length the gonad and its ducts are attached and open to the exterior. In some species, such as *Ischnochiton magdalenensis*, the ducts are highly glandular and it is possible, though it appears to us improbable, that this glandular section is of ectodermic origin.

¹ Zool. Jahrb., Suppl. 4 (Fauna Chilensis, Vol. 1).

² Heath, Zool. Jahrb., Bd. 21, p. 729.